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Fruit Ripening Chamber for Farmers by Using Ethane and Electronic Control Unit

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ABSTRACT:Ripening is the process, by which fruits attain their desirable flavour, quality, colour, palatable nature and other textural properties. Ripening is associated with change in composition i.e. conversion of starch to sugar. On the basis of ripening behaviour, fruits are classified as climacteric and non-climacteric fruits. Climacteric fruits are defined as fruits that enter 'climacteric phase' after harvest i.e. they continue to ripen. During the ripening process the fruits emit ethylene along with increased rate of respiration. Ripe fruits are soft and delicate and generally cannot withstand rig ours of transport and repeated handling. These fruits are harvested hard and green, but fully mature and are ripened near consumption areas. Small dose of ethylene is used to induce ripening process under controlled conditions of temperature and humidity.

KEYWORDS: Ripening, Climacteric Fruit, Ethylene, Fruit ripening.

I.INTRODUCTION

Fruits are one of the best natural food usually consumed raw. Now a days fruits are deliberately being contaminated by chemicals causing serious health hazard. Among the pre-treatments, which are mostly followed for fruits intended for better consumer acceptance and facilitating better marketing is artificial fruit ripening. Artificial ripening is done to achieve.

However, ripening, in general, is a physiological process which makes the fruit edible, palatable and nutritious. In nature fruits ripen after attainment of proper maturity by a sequence of physiological biochemical events and the process is irreversible. Whether fruits ripen on the plant or after harvest, the general changes associated with ripening process is softening of fruit, changes in color and development of characteristics aroma and flavor. There is also reduction in sourness and increase in sweetness of the fruit. Usually fruits produce ethylene gas, a plant hormone, naturally that ripens the fruits.

Unsaturated hydrocarbons such as acetylene, ethylene etc. Can promote ripening and induce color changes effectively. Although the cosmetic quality of such artificially ripened fruits was found toimprove, organoleptic quality was impaired especially when harvested fruits are subjected to treatment without considering their maturity status. Besides, the quality of ripening agent required to induce ripening for better cosmetic quality, including appearance will be much more than conventional dose, when properly nature are not used for such purposes.

Ripening is the process by which fruits attain their desirable flavor, quality, color, palatable nature and other textural properties. Ripening is associated with change incomposition i.e. conversion of starch to sugar. On the basis of ripening behavior, fruits are classified as climacteric and non-climacteric fruits. Climacteric fruits are defined as fruits that enter 'climacteric phase' after harvest i.e. they continue to ripen. During the ripeningprocess the fruits emit ethylene along with increased rate of respiration. Ripefruits are soft anddelicateand generally cannot withstand rigors of transport and repeated handing.

These fruits are, therefore, harvested hard and green but near full maturity and are ripened near consumption areas by using ripening aid. Even fully mature fruits of this category may be ripened by using ripening aid to get uniform ripening in large lots for bulk transport and marketing.Small dose of ethylene is used to induce ripening process under controlled conditions of temperature and humidity.

Climacteric fruits are mango, banana, papaya, guava, sapota, kiwi, persimmon, fig, apple, passion fruit, apricot, plum and pear. Non-climacteric fruits once harvested do not ripen further. Non-climacteric fruits produce very small amount of ethylene and do not respond to ethylene treatment. There is no characteristic increased rate of respiration or production of carbon dioxide. Non-climacteric fruits are citrus, pineapple, grape, strawberry, pomegranate, lichi, watermelon and cherry.

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II.TECHNOLOGIES FOR RIPENING OF FRUITS

Lack of easier and rapid methods for uniform ripening poses a major problem in the fruit industry. Almost all methods of ripening, either conventional or the modern chemical methods, come with their own merits and demerits. There are several simple technologies and methods available today for farmers for proper ripening. Normally, the number of days taken for edible ripening varies for different fruits and prevailing climatic conditions. For instance, it takes about 5 to 6 days for mangoes and 6 to 7 days for sapotas to ripen.

Fig.1 Mangoes Ripening in Air Tight Rice Bin

Under natural conditions, ethylene, a ripening hormone produced by the plant plays a major physiological role in the ripening process.

- A simple technology practiced in households to trigger ripening is to keep unripened and ripened fruits together inside an air tight container. Since the already ripened fruits release ethylene, ripening will be faster.
- Another method is to place the fruits intended for ripening inside an air tight room and induce ripening through smoking inside smoke chambers. Smoke emanates acetylene gas. Several fruit traders follow this technique to achieve uniform ripening especially in edible fruits like banana and mango. But the major drawback of this method is that the fruits do not attain uniform color and flavor. In addition, the persistence of smoke odour on the product impairs its quality
- Spreading unripe fruits as layers over paddy husk or wheat straw for a week to ripen is another alternative.
- Another practice is that some farmers dip unripe mature fruits in 0.1 per cent ethrel solution (1 ml of ethrel solution in 1 liter of water) and wipe it dry. The fruits are then spread over a newspaper without touching each other and a thin cotton cloth is covered over this. In this method, the fruits will ripen within two days.
- In one of the simple and harmless techniques, 10 ml of ethrel and 2 gm. of sodium hydroxide pellets are mixed in five liters of water taken in a wide mouthed vessel. This vessel is placed inside the ripening chamber near the fruits and the room is sealed air tight. About a third of the room is filled with fruits leaving the remaining area for air circulation. Ripening of fruits takes place in about 12 to 24 hours. In order to reduce the cost of chemical, some ethylene releasing fruits such as papaya and banana can also kept in the same room.
- Ethylene gas filled in pressurized cans promote fruit ripening in 24-48 hours

Fig 2 Mangoes Ripening Using Paddy Straw

Most climacteric fruits in India are ripened with industrial grade calcium carbide. Industrial-grade calcium carbide usually contains traces of arsenic and phosphorus, and, thus, use of this chemical for this purpose is illegal in most countries. In India too, use of calcium carbide is strictly banned as per PoFA (Prevention of Food Adultration) Act [Section 44AA]. Calcium carbide, once dissolved in water, produces acetylene which acts as an artificial ripening agent. Acetylene is believed to affect the nervous system by reducing oxygen supply to brain. Arsenic and phosphorus are toxic and exposure may cause severe health hazards.

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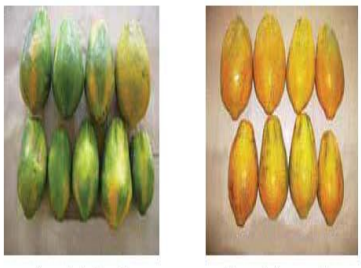

Fig 3 Uniform Ripening of Papaya Fruits using Ethylene Gas

The only safe and worldwide accepted method is using ethylene, which is a natural hormone for ripening when done under controlled temperature and relative humidity conditions.

Fig 4. Workers at a Fruit Market using Calcium Carbide to Ripen Raw Mangoes

Ethylene being a natural hormone does not pose any health hazard for consumers of the fruits. It is a de-greening agent, which can turn the peel from green to perfect yellow (in the case of bananas) and maintain the sweetness and aroma of the fruit, thus value addition in the fruit is possible as it looks more appealing. It has been known for a long time that treatment of unripe fruits with ethylene would merely stimulate natural ripening until the fruit itself starts producing ethylene in large quantities.

III. METHODOLOGY

Ripening is a process in fruits that causes them to become more palatable. In general, a fruit becomes sweeter, less green, and softer as it ripens. Even though the acidity of fruit increases as it ripens, the higher acidity level does not make the fruit seem tarter. This is attributed to the Brix-Acid Ratio.Ethylene gas is currently an approved material for use on bananas for the fresh market. Its approval is based on the specific requirements of banana production and marketing as well as the fad that ethylene is naturally occurring byproduct of ripening fruits.

Since ethylene is approved by the NOSB and the European community for certain applications and presenting the case for extending its use in another specific instance rather than information on the material itself. Specifically, It is used to facilitate the production of high quality dried fruit. Without the use of a ripening agent the cost of producing organic dried mango will be significantly higher than conventional and the quality will be lower.

Some certification agencies allow the use of ethylene in tropical dried fruit processing. Others do not specifically disallow it. Tropical dehydration facilities that process both banana and mango (or papaya and other fruits) can use ethylene for one item and not another. There is no logical basis for this. A ruling from OMRI will take the current ambiguity and inconsistency out of this area.Ripening for preparation for drying is done in well-sealed champers typically on the scale of 3000 Cu, Ft. Ethylene gas is introduced to manufacturer specified concentrations for a period of 16 to 24 hours. No temperature controls are used in the champers. Typically 16 hours is sufficient and the rooms are vented at this time as the fruit begins to produce ethylene gas by itself and will continue ripening without help.

A. ***Ripening Agents****:* Ripening agents speed up the ripening process.They allow many fruits to be picked prior to full ripening, which is useful, since ripened fruits do not ship well. For example, bananas are picked when green and artificially ripened after shipment by being gassed with ethylene.Calcium carbide is also used in some countries for artificially ripening fruit. When calcium carbide comes in contact with moisture, it produces acetylene gas, which is quite similar in reaction to the natural ripening agent ethylene. Acetylene acts like ethylene and accelerates the ripening process. Industrial-grade calcium carbide may also contain traces of arsenic and phosphorus which makes it a human health concern. The use of this chemical for this purpose is illegal in most countries. Catalytic generators are used to

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produce ethylene gas simply and safely. Ethylene sensors can be used to precisely control the amount of gas. Covered fruit ripening bowls are commercially available. The manufacturers claim the bowls increase the amount of ethylene and carbon dioxide gases around the fruit, which promotes ripening.Climacteric fruits are able to continue ripening after being picked, a process accelerated by ethylene gas. Non-climacteric fruits can ripen only on the plant and thus have a short shelf life if harvested when they are ripe.

B. ***Ripening Indicators:***Iodine (I) can be used to determine whether fruit is ripening or rotting by showing whether the starch in the fruit has turned into sugar. For example, a drop of iodine on a slightly rotten part (not the skin) of an apple will stay yellow or orange, since starch is no longer present. If the iodine is applied and takes 2–3 seconds to turn dark blue or black, then the process of ripening has begun but is not yet complete. If the iodine becomes black immediately, then most of the starch is still present at high concentrations in the sample, and hence the fruit hasn't fully started to ripen.

C. ***Ripening Stages:***Climacteric fruits undergo a number of changes during fruit ripening. The major changes include fruit softening, sweetening, decreased bitterness, and color change. Color change is the result of pigments, which were always present in the fruit, becoming visible when chlorophyll is degraded. However, additional pigments are also produced by the fruit as it ripens. In fruit, the cell walls are mainly composed of polysaccharides including pectin. During ripening, a lot of the pectin is converted from a water-insoluble form to a soluble one by certain degrading enzymes. These enzymes include poly galacturonase. This means that the fruit will become less firm as the structure of the fruit is degraded.Enzymatic breakdown and hydrolysis of storage polysaccharides occurs during ripening. The main storage polysaccharides include starch. These are broken down into shorter, water-soluble molecules such as fructose, glucose and sucrose. During fruit ripening, gluconeogenesis also increases. Acids are broken down in ripening fruits and this contributes to the sweeter rather than sharp tastes associated with unripe fruits. In some fruits such as guava, there is a steady decrease in vitamin C as the fruit ripens. This is mainly as a result of the general decrease in acid content that occurs when a fruit ripens.

D. ***Ethephon Chemistry and Ethylene Release:***The class formula for the 2-chloroalkylphosphonic acids (MAY63596) is,**R—CH (Cl)—CH_2—PO_3H_2**, The hydrolysis at pH 5 and above produces chloride, phosphate, and ethylene (MAY63596). It was suggested that a chemical mechanism involving nucleophilic attack on the phosphate dianion by water was responsible for ethylene production (MAY63596, YAN69203). This resulted in the elimination of chlorine and the formation of phosphate.**CI—CH_2—CH_2−−PO_3H_2 + OH→ CH_2=CH_2 + CI + H_3PO_4**, Quantitative evolution of ethylene was obtained by treating ethephon with excess base at 75°C for 10 minutes (C0068974). The yield of ethylene anc phosphate were equal and when [3$H_2$0 was present, [3H] did not appear in the olefin, indicating that dehydrohalogenation was not a part of the reactor (YAN69203**).**

E. ***Ethephon Residue Tolerance:***Published toxicological data for ethephon indicate that the levels in milligrams per kilogram per day which had no observable effect are: 90-day feeding (dog), 5; 3-generation reproduction study (rat), 75; teratology (rabbit), 50; neurotoxicity (chicken), 1000; and 2-year oncogenicity (rat), I .5 (ENV85105: Based on these studies, the acceptable daily intake of ethylene is 7.5 mg/kg/day) This value adjusted to a 60-kg human with a 100-fold safety factor becomes 4. mg/day. The residue tolerance factor for ethephon on wheat and barley is 0.1 ppm, ethylene does not have a physiological effect on micro-organisms, insects, or animals at the µl\liter levels used to alter plant growth Ethephon should break down in aqueous animal fluids in a manner similar to the occurring in plants. Its conversion to ethylene minimizes it as a hazard. Ethephon can be analyzed by gas chromatography (BAC70730) a] [3IP] NMR (LAN86577). The GC method is the more sensitive of the two Ethephonlabelled with has been used to study its absorption, translocation and metabolism.

F. **Methods of Applying Ethrel:**Method selected for applying ethylene depends on cost, convenience and safety factors. Use of diluted ethylene gas mixtures is safer than using pure ethylene, which is explosive and flammable at concentrations of 3% or higher. Fruit to be ripened ideally is placed in an airtight ripening room maintained at a constant temperature (18-21^{o}C for most fruits, but 29-31^{o}C in mango). Optimum storage and ripening temperatures for a few fruits are tabulated in table 1.

There are two methods of exposing fruit to ethylene. Trickle method involves trickling ethylene gas into room so as to maintain a concentration of 10 µl per litre, usually for a period of 24 hours. During this time, relative single initial charge of ethylene at a concentration of 20 to 200 µl /litre. Room is then ventilated after 24 hours to prevent carbon dioxide exceeding 1% concentration, which would retard ripening. Rooms that are poorly sealed are packed in vented cartons stacked on pallets, and fruit temperature is controlled by forced air circulation as in a cooling facility. A small fan can be used to ensure a uniform continuous flow of ethylene into and through the room. Forced-air ripening provides more uniform temperature and ethylene concentration throughout ripening room.

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Table 1 Optimum storage and ripening temperatures

Commodity	Ethylene conc.(ppm)	Ethylene exposure time (hr.)	Ripening temp. ^{o}C	Storage Temp.^{o}C
Avocado	10-100	12-48	15-18	4.4-13
Banana	100-150	24	15-18	13-14
Honey dew melon	100-150	18-24	20-25	7-10
Kiwifruit	10-100	12-24	0-20	0.5-0
Mango	100-150	12-24	20-22	13-15
Orange degreening	1-10	24-72	20-22	5-9
Stone fruit	10-100	12-72	13-25	-0.5-0

IV. FABRICATION OF CHAMBER

The Fig. 5 shows the block diagram of fruit ripening chamber. The power supply is given to the timer unit and the timer unit is used as a regulator to control the timing of each spray. Once the timer switches ON then the pump sprays the ethylene in to the chamber.The blower fan makes the ethynle flow even in the chamber.If the temperature and co_2 level exceeds the exhaust fan switches ON and the temperature in the chamber is reduced. The fruit ripening chamber 2D diagram is as shown in the Fig. 6.

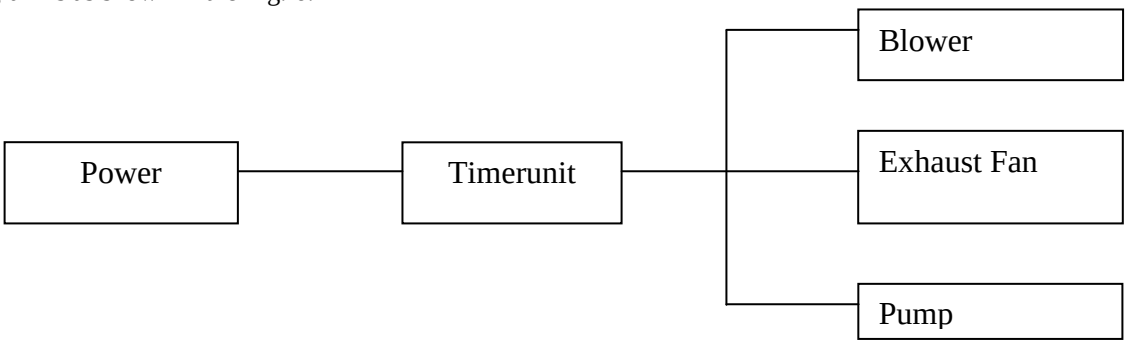

Fig. 5 Block diagram of Fruit Ripening Chamber

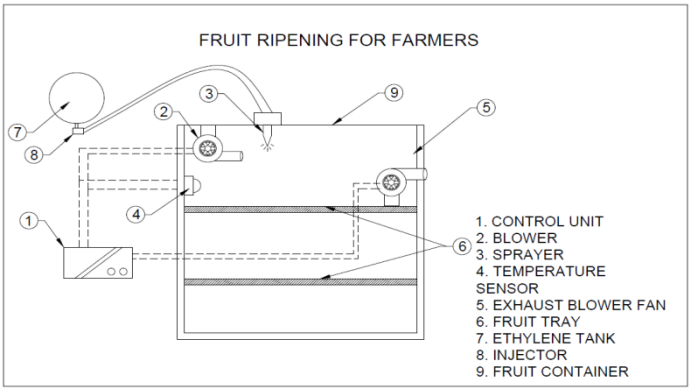

Fig. 6 2D diagram of Fruit Ripening Chamber

Here the control unit is used to control the total system.Blower is used to blow the ethylene evenly in to the holes chamber.The sprayer is used to spray the ethylene to the blower.The fruit container is a container used to store the fruits.The exhaust fan is used to eliminate the over head that is produced by the breathing of fruits.Fruit tray is used to arrange the fruits in order on the tray.

The major components that are used in the project FRUIT RIPENING FOR FARMERS are as follows,

- Electronic timing control unit,Blower,Sprayer,Fruit container,Exhaust fan,Ethylene gas,Fruit tray,and Temperature sensor

The major working of the fruit ripening for the farmer is that the proper usages of the ethylene gas over the fruits. This unit consists of the fruit tray on which the fruits are to be placed, which are to be ripened. It consists of the blower unit for making the ethylene gas to spread over the fruits in the bed or tray. The fruits are kept in the tray which is kept under the spraying unit which continuously sprays the ethylene gas on the fruit.

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Fig. 7 Fruit Ripening Chamber& Front View

The ethylene gas is sprayed through the sprayer which is held near by the blower unit. The blower unit is used to spread the air molecules throughout the container. All the actions of the sprayer, blower unit and the exhaust fan is controlled by the electronic timing control unit.When the fruits are kept in the tray and switched on the electronic timing control unit. The control unit makes the blower to run and spread the air all over the container, when the ethylene gas sprayer starts spraying the ethylene and it is made to spread using the blower unit.The ethylene spreads all over the fruit and makes the fruit to ripen and then the excess gas is removed from the container through the exhaust by operating the exhaust fan. These actions are controlled by the control unit which has a preprogrammed microcontroller unit. It controls the action of the spraying the ethanol. If the excess of the ethanol is sprayed on to the fruits, it makes the fruit to get damaged and makes not sufficient for the eating purposes. So only the limited amount of the ethylene gas is sprayed on the fruit using the control unit.

The above shown figure is the hardware module of our project. Which consists of a tank in which the ethanol can be filled. There is a DC pump connected to the tank. Then a sprayer nozzle is attached to the pump which sprays the ethanol into the chamber. A blower is connected near the nozzle.

Fig. 8 Fruits before Ripening

Which blows the ethanol into the chamber. And a temperature sensor to maintain the temperature in the chamber. An exhaust blower is there in the chamber to reduce the existing temperature from the set temperature. This is the chamber in which we are going keep the climatic fruits, once it been stored in the chamber. The ethanol is sprayed inside the chamber. Which fastens the ripening of the fruits which is inside the chamber. The figure shows that the fruits are stored in the chamber. Which is kept on the tray. The fruit kept in the chamber is green, hard, and not tasty. The above picture shows that the chamber is closed with the fruits inside. Which is fully closed and the ethanol is sprayed. So the ripening hormones is induced in the fruits which makes the fruits to ripen faster.

- **STEP-1:** Bananas hanging on a tree is green, plenty hard and not tasty. Over time, of course, they become softer and sweeter. The cause of fruit ripening is a natural namely a gases plant hormone caused ethylene. Green; when the surface of the banana is completely green.
- **STEP-2:** The ethylene starts to produce in the fruits once if been picked. That generates the ripening process of the fruits. When less than 10% of the surface, is red
- **STEP -3:** The fruit is carefully kept in the container and the ethylene is sprayed on to the fruits and the temperature is set from 25.c to 30.c. So that the ripening of the fruit is fasten. In this process every climatic fruits can be ripened. Every fruit requires an individual temperature for its ripening. To control the temperature in this system a temperature sensor is used so the temperature can be controlled very easily.

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- **4 HOURS:** The ethylene starts to react in the fruits. When the reaction takes place the ripening hormones are generated in the fruits. The surface of the fruit is green. Once the fruit starts to ripen its color starts turning and the fruits becomes sweeter and soft.
- **8 HOURS:** After eight hours the ethylene is built in the container. The fruit starts to turn its color. The surface color of the fruit turns less than 10% in this process time there is a slight change in the color of the fruit. But is a very less change in the surface.
- **12 HOURS:** The temperature in the container is maintained in the box and the ethylene level. Is also maintained by proper ethylene spray at constant intervals. In this process the surface becomes even darker. Which is less than 30%but not less than 10%.
- **16 HOURS:** In this method the color of the fruit turns darker which is less than 60% but not less than 30%.At this process the temperature will increase more than 30.c .so, the exhaust fan is used to reduce its temperature. By reducing its temperature the fruits can be ripen fast without damaging the fruits.
- **20 HOURS:** At this stage the surface the surface is light yellow and it's ripen but less than 90%. The fan is kept on till the process is complete to keep the ethylene flow constant.
- **24 HOURS:** At this stage the fruits is surface is completely yellow. And the fruit is fully ripen. It becomessweet, soft once it is ripen.

Fig. 9 Fruits after 16 Hours which is Kept inside the Chamber&the Ripened Fruit after the Process

V. CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries.We are proud that we have completed the work with the limited time successfully. The **FABRICATION OF FRUIT RIPENING CHAMBER FOR FARMERS** is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities.In conclusion remarks of our project work, let us add a few more lines about our impression project work. Thus we have developed a **"FRUIT RIPENING CHAMBER FOR FARMERS"** which helps to ripen the fruits automatically in a short period of time. Also the cost of the system is less and makes the project more feasible. By using more techniques, they can be modified and developed according to the applications.

REFERENCES

[1] Abeles, F.B. (1992) 'Ethylene in Plant Biology', 2nd edition. Academic Press, NY.
[2] Bramley, P.M. (2002). Regulation of carotenoid formation during tomato fruit ripening and development. J. Exp. Bot. 53, pp.2107–2113.
[3] Chace, E.M. (1934) Health Problems Connected with the Ethylene Treatment of Fruits. Amer Jour Pub health 24: pp.1152 – 1156.
[4] Chao, Q., Rothenberg, M., Solano, R., Roman, G., Terzaghi, W., and Ecker, J. (1997) 'Activation of the ethylene gas response pathway in Arabidopsis by the nuclear protein', ETHYLENE-INSENSITIVE3 and related proteins. Cell 89, pp. 1133–1144.
[5] Clendennen, S.K. (1997) The Role of Ethylene in Banana Fruit Ripening. In Kanellis, A.K. ed., Biology and Biotechnology of the Plant Hormone ethylene. NATO AS1 series.
[6] Coody, and Lynn (1996) Memo to Oregon Tilth concerning the use of calcium carbide to induce flowering in pineapple. Submitted to the USDAMOSB with the petition for ethylene use for ripening pineapple.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

|| Volume 9, Issue 7, July 2020 ||

[7] Cui-Cui Yin, Biao Ma, Derek Phillip Collinge, (2015) 'Ethylene Responses in Rice Roots and Coleoptiles Are Differentially Regulated by a Carotenoid' Isomerase-Mediated Abscisic Acid Pathway, the Plant Cell, Vol. 27: pp.1061–1081, American Society of Plant Biologists.
[8] Denny, F.E (1924) Hastening the coloration of 1emons.J 4gr. Res, 27:pp757-769.
[9] Formisano, F. Massera, E. De Vito, S. Buonanno, A. Di Francia, G. and P. DelliVeneri, (2014) 'RFID tag for vegetable ripening evaluation using an auxiliary smart gas sensor,' SENSORS, IEEE, Valencia, pp. 2026-2029.
[10] Formisano, F. Massera, E. De Vito, S. Buonanno, A. Di Francia, G. andDelliVeneri, P. (2015) 'Auxiliary smart gas sensor prototype plugged in a rfid active tag for ripening evaluation,' AISEM Annual Conference,XVIII, Trento, pp. 1-4.
[11] Ghosh, A, Ali, A. and Ranford, S. (2011) 'Analysis of the interference of moisture on ethylene hormone detection with a palladium complex,' Sensing Technology (ICST), Fifth International Conference on, Palmerston North, pp. 679-684.
[12] Hallur, V. Atharga, B. Hosur, A. Binjawadagi, B. andBhat, K. (2014) 'Design and development of a portable instrument for the detection of artificial ripening of banana fruit,' Circuits, Communication, Control and Computing (I4C), International Conference on, Bangalore,(2014), pp. 139-140.
[13] Lang, W. andJedermann, R. (2015) 'The intelligent container -What can MEMS do for logistics of food?' SENSORS, IEEE, Busan,pp. 1-4.
[14] Lv, G. Yang, H. Xu, N and Mouazen, A. M. (2012) 'Identification of less-ripen, ripen, and over-ripen grapes during harvest time based on visible and near-infrared (Vis-NIR) spectroscopy, Consumer Electronics, Communications and Networks (CECNet), 2nd International Conference on, Yichang, pp. 1067-1070.
[15] Medlicott, A. P. and Thompson, A. K. (1985), Analysis of sugars and organic acids in ripening mango fruits (Mangiferaindica L. varKeitt) by high performance liquid chromatography. J. Sci. Food Agric., Vol.36, pp. 561–566.
[16] Medlicott A. P. Sigrist J. M. Reynolds S. B. and Thompson A. K. (1987) Effects of ethylene and acetylene on mango fruit ripening. Atrialso Applied Biology III, pp.439-444.
[17] Oetiker, J.H, S.F. Yang (2001) 'The Role of Ethylene in Fruit Ripening' International Society for Horticultural Science, pp. 11-17.
[18] Pantastico E. B. and Mendoza D. B. (1970) 'Production of ethylene and acetylene during ripening and charring'. Philippine Agriculturist 53, pp.477-484.
[19] Smith N. J. S. and Thompson A. K. (1987) 'The elects or temperature. Concentration and exposure tin low etylene on initiation of banana ripening', Journal of the Science of Food Agriculture 40, pp.43-50.
[20] Sy. O and Wainwright, H. (1990) 'Natural Resources Institute (NRI), Central Avenue', Chatham Maritime, Kent ME4 4TB, UK, Trap. Sci. Vol.30, pp. 411-420.
[21] Tantisopharak, T. Krairiksh, M. and Sarkar, T. K. (2013) 'Experimental study using natural frequencies for fruit identification,' Radar Conference, IET International, Xian, pp. 1-4.
[22] Thompson A. K. and Seymour G. B. (1982) 'Comparative effects of acetylene and ethylene gas on initiation of banana ripening', Annals Applied Biology) 101, pp.407-410.
[23] Zhen Yifan and Rao Honghui, (2011) 'Effects of high voltage electrostatic field treatment on post-harvest physiology of Kiwifruit,' New Technology of Agricultural Engineering (ICAE), International Conference on, Zibo, pp. 994-997.